# Ask Dr. ALOHA:
## A Chemistry Quiz

Although ALOHA is designed primarily to serve as an emergency response tool, it has other uses. For one thing, you can use ALOHA to build your intuition about the hazardous chemicals present in your community or fire district. Here's an ALOHA chemistry quiz you can take to test your knowledge of both chemistry and ALOHA. The best way to answer most of the quiz questions is to experiment with ALOHA and to check CAMEO when you need more information. Once you think you've found the answers, or you're ready to give up, turn to the end of this article to see the answers.

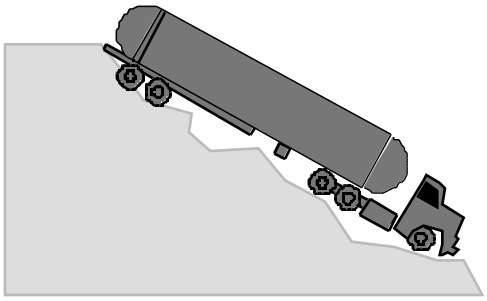
### The questions

1. There's been an oil spill near a small town in southern Oregon. As a member of the local volunteer fire department, you've arrived on scene. As oil begins to wash up on the beach, concerned residents have already arrived with buckets and shovels, eager to rescue oiled wildlife and birds and begin cleanup. One of your fire department colleagues wonders out loud: "Benzene evaporates from fresh oil—and isn't it a carcinogen? Maybe we need to take some health precautions." You grab the department's new laptop and start up ALOHA. What can it tell you about benzene's carcinogenicity?

2. It's a misty, humid morning in the Louisiana bayou country. The sky is cloudy and it's about 72 degrees F (22 degrees C). Your hazmat team has been dispatched to the scene of a traffic accident. A truck containing a box of cylinders of refrigerated liquid diborane has been struck by a car. Each cylinder measures 7 inches in diameter by 33 inches in length (18 by 84 centimeters) and contains 4.4 pounds (2 kilograms) of diborane. When you arrive on scene, it isn't yet clear whether any of the cylinders are leaking. You assign a team member to run ALOHA to evaluate the toxic hazard from a possible diborane release. After a few moments, he reports that toxicity isn't the only hazard diborane poses, and suggests that the team prepare for a firefighting response. Why would he say that?

3. You're a member of the Local Emergency Planning Committee (LEPC) for Middletown, South Dakota. You and your colleagues have just completed an inventory of the hazardous chemicals in your town, and have discovered that one of the chemicals stored and used in the greatest quantities in Middletown is sulfuric acid. Someone volunteers to model some sulfuric acid scenarios in ALOHA, but the chairperson tells him not to bother. Why? And why isn't sulfuric acid in ALOHA's chemical library? It's a very widely used chemical that is toxic when inhaled.

4. You're the emergency manager for Big Bluff, Montana. The city's emergency dispatchers have just alerted you that a tanker truck containing anhydrous hydrogen fluoride ("HF"), stored at ambient temperature under its own vapor pressure, has slid down a highway embankment on the outskirts of town, and has come to rest in a ditch. It's a cloudy day in early April; the wind speed is about 3 knots, and the air temperature is 50 degrees F (10 degrees C). Your first thought is that HF is known for its ability to travel far downwind as a heavy cloud of gas and aerosol (that is, as a two-phase flow). The tanker truck is not leaking now, but if it ruptures or is punctured while being pulled back up onto the road, there could be a very dangerous release. A chemist has recently joined your staff. When you ask her for response recommendations, she runs ALOHA and immediately recommends diking the area around the tanker truck. But diking only makes sense when you're dealing with a spilled liquid, not with a heavy gas cloud. What could she be thinking?



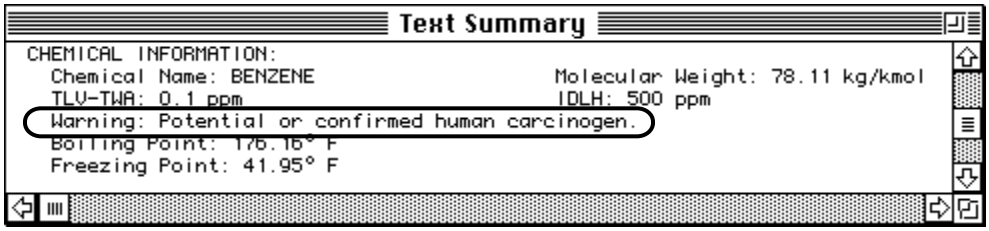
5. You're on vacation in Ankara, but you've brought along your laptop, with ALOHA and CAMEO installed on it. When a crowd gathers around the doors of a large, run-down factory, you stop and discover that there's been a spill of toluene inside. It has formed a pool on the factory floor, and has begun to evaporate. You can see that the space around the pool of toluene is cluttered with plenty of combustible materials and potential ignition sources. Toluene is flammable, so you're concerned about the potential fire hazard from the toluene vapor inside the factory. You guess that the temperature inside the factory is about 70 degrees F (21 degrees C). Could the toluene vapor concentration reach explosive levels? (Hint: check CAMEO to see toluene's explosive limits.)

6. As a member of a hazmat team in the Seattle Fire Department, you are responding to an incident in which formaldehyde has been released from a leaking container behind a University of Washington research laboratory (the formaldehyde has leaked out onto a parking lot and formed an evaporating puddle). The wind speed is about 5 knots, under clear skies, and the temperature is about 60 degrees F (15.6 degrees C). You estimate that the puddle is about 75 square feet (7 square meters) in area, and roughly an inch (2.5 centimeters) deep, on

average. You are asked to model this release in ALOHA, but when you try to set up the scenario, you are surprised. Why?

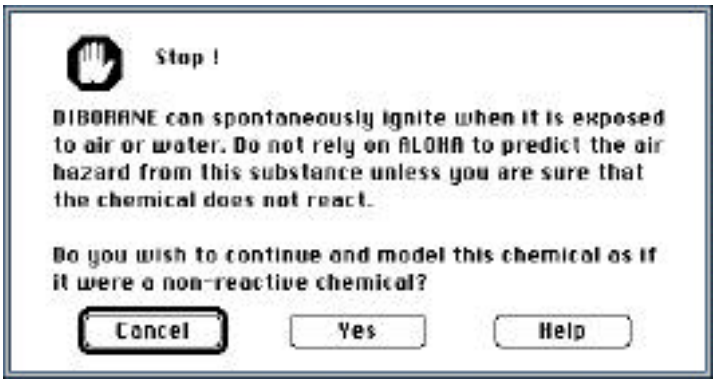
### The answers

1. To alert emergency responders, ALOHA reports whether a chemical has been identified as a suspected, potential, or confirmed carcinogen. To see this information, just choose the chemical from the chemical library, then check the Text Summary window. In the case of benzene, your Text Summary window, like the one below, will alert you that benzene has been identified as a potential or confirmed carcinogen.




To find out what health precautions to take to protect the cleanup volunteers, the fire fighters should contact their state or local health department or the Occupational Health and Safety Administration (OSHA), a Federal agency.

2. When the hazmat team member chose diborane from ALOHA's chemical library, he saw the alert message below.

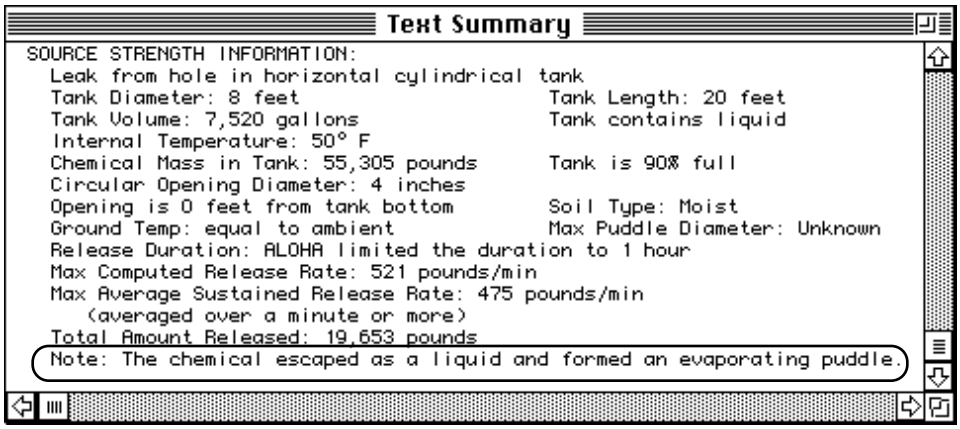



It tells him that diborane in moist air can spontaneously ignite to create a fire hazard. If he were to check CAMEO, he would find guidelines for responding to this hazard. Note that when diborane reacts with the water vapor in moist air, new compounds are formed, so that the dispersing chemical cloud will contain not only diborane gas, but also a mixture of the byproducts of its reaction with water. The reaction may also change the cloud's temperature. Because ALOHA doesn't account for such effects of chemical reactions, it can't model a release of diborane in moist air.

3. ALOHA's library includes all the pure chemicals in CAMEO that have been judged to be air dispersion hazards. Sulfuric acid has been judged not to be an

air dispersion hazard because, although it is hazardous when inhaled, it is not very volatile. That is, under normal conditions, it cannot enter the atmosphere fast enough to reach concentrations hazardous to people. You can see this by checking its properties in CAMEO. CAMEO reports that the vapor pressure of sulfuric acid is only 1 millimeter at 294.8 degrees F. This is a very low vapor pressure. In contrast, at the same temperature, water is a gas with a vapor pressure of about 44,000 millimeters.

4. In past accidents, HF has escaped from containment as a pressurized gas and has formed a heavy gas cloud. In some cases, it has killed and injured people. However, in those incidents, HF was stored above its boiling point of 67 degrees F (19.4 degrees C), so it escaped directly into the atmosphere as a cloud of gas and aerosol, rather than spilling onto the ground as a liquid. At Big Bluff, it's a cloudy day, with the air temperature well below the HF boiling point. The HF is stored at ambient temperature. If you run this scenario in ALOHA and choose the Tank source option, guesstimating the tank's dimensions and entering the ambient temperature as the tank temperature, ALOHA would report that the HF would flow from any rupture in the tanker truck as an unpressurized liquid instead of a pressurized cloud of gas and aerosol.

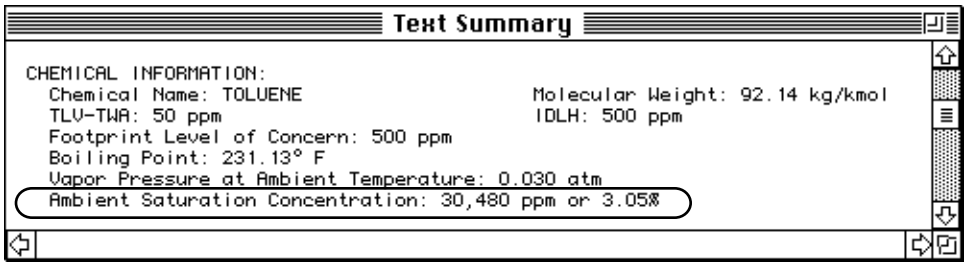



The liquid HF would form a pool in the bottom of the ditch, and then evaporate. This kind of release would pose a much smaller airborne hazard than a pressurized release of HF (it's easy to see this by experimenting with ALOHA). Since pool area has a big effect on the amount of vapor that evaporates, diking the area around the tanker truck to reduce the area of any pool that might form would be an effective response measure.

5. To find out the answer to this question, you need ALOHA's estimate of toluene's **ambient saturation concentration**, which you can then compare with its lower explosive limit. What's ambient saturation concentration? A flammable liquid such as toluene, stored in a confined space such as this factory, evaporates at a rate that depends on its temperature and on the amount of vapor that's already present in the air space above the liquid. Over time, the amount of evaporated vapor in that air space will stabilize at the ambient saturation concentration. The higher a chemical's ambient

saturation concentration, the greater is its ability to displace air, and the higher will be the concentration of the chemical's vapor in the air above the liquid. This property changes with temperature: a liquid at a higher temperature will have a higher ambient saturation concentration.

To obtain ALOHA's estimate of the ambient saturation concentration for toluene at 70 degrees F (21 degrees C), choose toluene from the chemical library, then enter weather conditions as follows: enter 70 degrees F as your value for air temperature, and any values you wish for all other weather inputs, since only temperature matters for estimating ambient saturation concentration. Then check the Text Summary window to see the estimated ambient saturation concentration. In this case, it is 30,480 parts per million, or 3.05 percent, as shown below.




Toluene's lower explosive limit is 1.27 percent and its upper explosive limit is 7 percent (you can find these values in CAMEO). Since toluene's ambient saturation concentration is well above its lower explosive limit at this temperature, there is a clear danger of fire or explosion in the factory.

6. If you're using the current version of ALOHA, you'll find that although formaldehyde is a commonly-encountered hazardous chemical, it isn't in ALOHA's chemical library. Why? Because pure formaldehyde is a gas at room temperature and atmospheric pressure. However, it's very unusual to encounter formaldehyde in its pure state. Instead, it is available commercially as a solution of formaldehyde in water. ALOHA can model only pure chemicals, not mixtures or solutions (that's because it's very difficult to accurately predict chemical properties such as vapor pressure for solutions or mixtures, and ALOHA's release rate and dispersion estimates become invalid if property values are incorrect). Formaldehyde (as the pure gas) was included in the chemical library in earlier versions of ALOHA, but has been removed from the current version. This was done because pure formaldehyde is so rare that emergency responders are very unlikely ever to encounter it, and to eliminate the risk of users unknowingly modeling the pure chemical when it is the solution which has been spilled.

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